WHAT DOES IT TAKE TO RETROFIT AN URBAN WATERSHED TO MEET WATER QUALITY STANDARDS AND TMDLS?

Roger Copp[1] and Nick Ammons[2]

AUTHORS: [1]Service Leader, Water Resources Group, Brown and Caldwell, 41 Perimeter Center East, Suite 400, Atlanta, GA 30346, and [2]Deputy Director, Surface Water Management, Fulton County, Atlanta, GA 30303.
REFERENCE: Proceedings of the 2001 Georgia Water Resources Conference, held March 26-27, 2001, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, the University of Georgia, Athens, Georgia.

Abstract. Fulton County sponsored a watershed management planning study and a retrofit plan was developed for the Sandy Springs area north of Atlanta. Detailed studies were conducted to determine existing water quality problems and to identify solutions to improve water quality and to reduce flooding. The plan identified 20 bridge and culvert replacements, 24 pond retrofits, 40 new ponds, 20 in-stream BMPs, 135 on-site BMPs (e.g. edge of parking lot filters, ecoroofs), and 4.8 miles of stream restoration. The total cost of the restoration project will be in the range of $68,700,000, of which 13% is for flood control. The BMPs are predicted to reduce the phosphorus load from the study area by 26% and will result in an average phosphorus concentration of 0.1 mg/l in Sandy Springs streams without lakes and 0.05 mg/l for stream with lakes. These BMPs are expected to improve stream health so that aquatic integrity can improve from poor to fair conditions. The recommended strategy is being proposed to the State of Georgia as a plan to achieve a TMDL goal of compliance with State water quality standards.

INTRODUCTION

Fulton County sponsored a watershed management planning study and a retrofit plan was developed for the Sandy Springs area north of Atlanta (Brown and Caldwell, 2001). The study area is approximately 23 square miles, 22% impervious, and there are approximately 23,700 dwelling units. Portions of the watershed are more than 40% impervious. Detailed studies were conducted to determine existing flooding and water quality problems. Potential solutions were evaluated to improve water quality and to reduce flooding. This project provides a detailed road-map for implementation of retrofit BMPs to restore water quality in an existing urban watershed. The process used to develop the plan can serve as a model for other urban areas of Georgia.

METHODS

Storm water monitoring was conducted to evaluate water quality and determine the hydrologic response of the streams to upstream land use changes. Stream surveys were also conducted to identify stream erosion. The monitoring and stream surveys identified flooding problems at numerous locations, and water quality problems due to non-point source runoff, leaking sanitary sewers, and possibly improperly maintained septic systems. Concurrent efforts are underway to reduce the frequency and magnitude of sanitary sewer overflows, and the County is developing a strategy to further evaluate the impact of septic systems. Non-point source runoff was found to contribute pollutants to the streams and to cause stream erosion. Georgia Environmental Protection Division listed Long Island Creek and Marsh Creek as not meeting designated water quality criteria due to fecal coliform bacteria. Control of non-point source runoff through construction of storm water retrofits was identified as a potentially effective strategy to reduce stream velocity and peak runoff rates. Storm water retrofits would also reduce storm water pollutants such as phosphorus and fecal coliform bacteria. Because fecal coliform levels were influenced by both overflowing sanitary sewers and non-point sources, and because there is an extensive database on the effectiveness of storm water BMPs to remove phosphorus, phosphorus was used as an indicator parameter for water quality improvements. This approach is consistent with other watershed restoration strategies that target phosphorus as a key pollutant (Kumble et. al., 1993) Target annual average concentrations of 0.1 and 0.05 mg/l TP were selected for streams and lakes, respectively. These target concentrations were identified after a literature review of water quality impacts to urban streams (U.S. EPA, 1998).

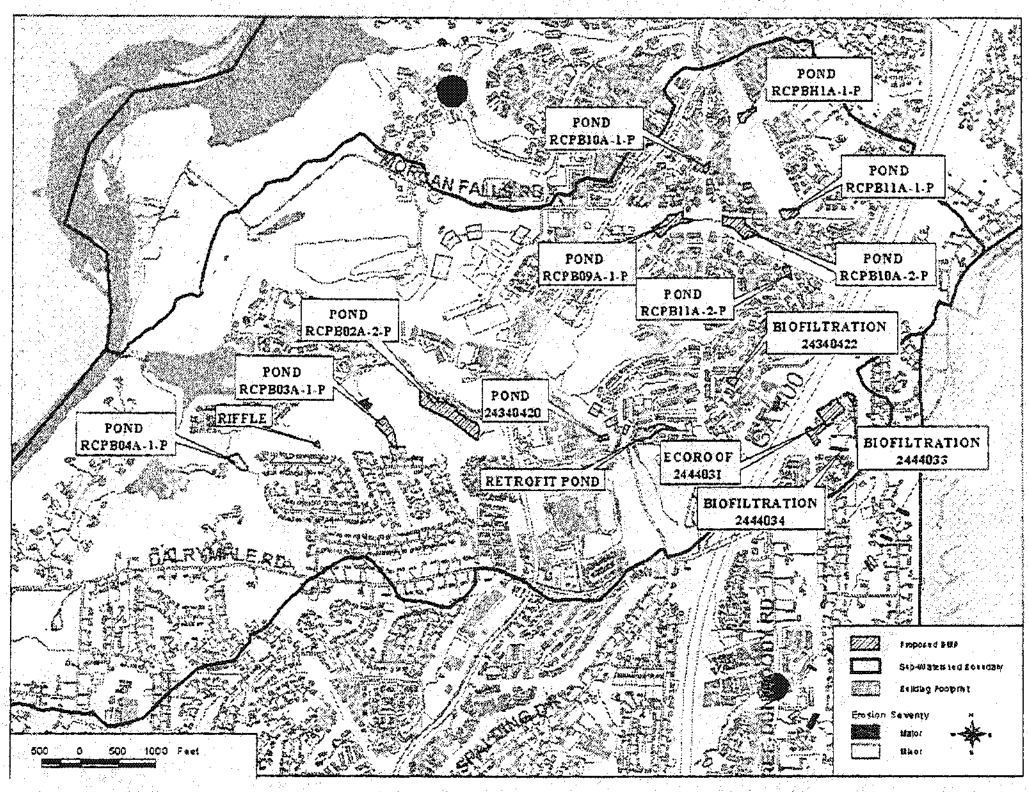

Figure 1. BMPs Recommended for Powers Branch.

In this analysis, a number of new Best Management Practices (BMPs) were identified, and retrofits to existing ponds were also identified. The process that was used to identify and select appropriate BMPs is described below:

- Degraded stream reaches were identified through and analysis of results from water quality monitoring, stream surveys to identify erosion, hydrologic/hydraulic modeling, and water quality modeling (Brown and Caldwell, 2001).
- Appropriate locations for installation of retrofit BMPs were identified using land use maps, aerial photographs, topographic data, and field reconnaissance.
- Outlines of the BMPs were digitized into a GIS ArcView file, and the drainage area to each BMP was determined and digitized. Both on-site (e.g. ecoroofs, edge-of-parking lot biofilters, cisterns) and off-site regional BMPs (e.g. detention ponds, check dams, wetland treatment systems) were added to the database.
- Pollutant load reductions and costs for each BMP were determined and entered into the GIS attribute table. Sources included Driscoll, 1983; Winer, 2000; Schueler, 1999; Roofscapes, 1999; and Roselfeld et. al., 1997.
- An ArcView program was written to calculate pollutant loads to each BMP and watershed, determine pollutant removals, and sum the cost of BMPs needed for each watershed (Slawecki, Copp, and Zahorcak, 2000).
- BMPs were selected for each watershed until the pollutant load reduction goal was achieved.
- Alternatives evaluated included: on-site BMPs, regional BMPs, and a mix of both on-site and regional BMPs. The alternatives analysis gave preference to BMPs that maximized pollutant removal while minimizing cost.
- BMPs were rejected from consideration if significant public opposition was encountered during general meetings with the public and/or individual meetings with homeowner associations. The ArcView tool was used to compare and explain the benefits and liabilities of different mixes of BMPs in public meetings.
- Quantity control BMPs were evaluated using hydrologic/hydraulic modeling using SWMM and HEC-RAS.

The plan identified 20 bridge and culvert replacements, 24 pond retrofits, 40 new ponds, 20 in-stream BMPs, 135 on-site BMPs (e.g. edge of parking lot filters, ecoroofs), and 4.8 miles of stream restoration. The total cost of the restoration project will be in the range of $68,700,000, of which 13% is for flood control. Figure 1 illustrates a mix of BMPs selected for a portion of the study area.

The cost per property or parcel was calculated by using GIS to apportion cost as a function of impervious land per parcel. Those parcels with impervious land would pay more than parcels with less impervious land. Median costs were provided for residential parcels, commercial parcels, and DOT parcels (I-285 and Georgia 400). The median costs for water quality BMPs are listed in Table 1. The high cost of improving water quality in this existing urbanized watershed illustrates the challenge of addressing problems after the watershed is developed.

Table 1. Utility Fee Calculations

Land Use Category	Statistic	Equivalent Annual Storm Water Fee
Residential	Median	$ 238
Commercial	Median	$ 1,438
Institutional	Mean	$ 3,812
DOT	Overall	$315,068

CONCLUSIONS

This mix of BMPs is predicted to reduce pollutant concentrations in urban runoff. The BMPs are predicted to reduce the phosphorus load from the study area by 26% and will result in an average phosphorus concentration of 0.1 mg/l in Sandy Springs streams without lakes and 0.05 mg/l for stream with lakes. These BMPs are expected to improve stream health so that aquatic integrity can improve from poor to fair conditions. Combined with improvements to sanitary sewers and potentially septic systems, non-point source controls are expected to significantly reduce fecal coliform levels in Sandy Springs streams. The recommended strategy is being proposed to the State of Georgia as a plan to achieve a TMDL goal of compliance with State water quality standards. The BMPs will also reduce flooding problems and will reduce the frequency and magnitude of erosive stream velocities. Combined with implementation of stream restoration, the reduction of stream velocity will also improve stream habitat. The high cost of improving water quality in this existing urbanized watershed illustrates the challenge of addressing problems after the watershed is developed.

REFERENCES

Brown and Caldwell. 2001. Watershed Management Program for Sandy Springs, Fulton County, Georgia. Prepared for Fulton County Department of Public Works.

Driscoll, E.D. 1983. Performance of Detention Basins for Control of Urban Runoff Quality. Presented at the 1983 Symposium on Urban Hydrology, Hydraulics and Sedimentation Control. Univ. of Kentucky, Lexington, KY.

Kumble, P., L. Herson-Jones, and T. Schueler. 1993. 10% Rule Compliance: Urban Stormwater Quality Guidance for the Maryland Chesapeake Bay Critical Area. Prepared for the Chesapeake Bay Critical Area Commission.

McDonald. 1991.

Roofscapes, 1999. Ecoroofs – A Proven Way to Decrease Stormwater Impacts. Roofscapes, Inc., 7114 McCallum Street, Philadelphia, PA.

Rosenfeld, A.H., J.J. Romm, H. Akbari, and A.C. Lloyd. "Painting the Town White -- and Green." MIT's Technology Review. February/March 1997.

Schueler, T. 1987. Controlling Urban Runoff – a Practical Manual for Planning and Designing Urban Best Management Practices. Metropolitan Washington Council of Governments. Washington, D.C.

Schueler, T. 1999. The Economics of Watershed Protection. Center for Watershed Protection.

Slawecki, T.A., R.S. Copp, and C.L. Zahorcak, 2000. Application of a GIS Decision Support Tool to Urban Watershed Management in Fulton County, Georgia, Proceedings, Watershed 2000, Water Environment Federation.

U.S. Environmental Protection Agency. 1998. Phosphorus - Water Quality Standards Criteria Summaries: A Compilation of State and Federal Criteria. EPA 440-5-88-029.

Winer, R. 2000. National Pollutant Removal Performance Database for Stormwater Treatment Practices, 2nd Edition. Prepared by the Center for Watershed Protection, MD for U.S. EPA Office of Science and Technology.